

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A radiation-curable adhesive composition comprising at least one tackifier resin and at least one radiation-curable composition wherein said tackifier resin comprises monomer repeating units from at least one aromatic monomer and at least one acrylate monomer; wherein said radiation-curable composition can be cured by exposure to radiation, wherein said tackifier resin has a residual monomer concentration of less than about 600 ppm by weight based on the weight of said tackifier resin.
2. (Original) A radiation-curable adhesive composition according to claim 1 wherein said aromatic monomer is at least one selected from the group consisting of olefinic substituted aromatics.
3. (Original) A radiation-curable adhesive composition according to claim 2 wherein said aromatic monomer is selected from the group consisting of styrene, alpha-methyl styrene, vinyl toluene, indene, methylindenes, divinylbenzene, dicyclopentadiene, and methyl-dicyclopentadiene.
4. (Original) A radiation-curable adhesive composition according to claim 1 wherein said acrylate monomer has the general formula:



wherein R_1 is selected from the group consisting of hydrogen, aliphatic groups, and aromatic groups; wherein R_2 is selected from the group consisting of hydrogen, aliphatic

groups, and aromatic groups; and wherein R₃ is selected from the group consisting of hydrogen, aliphatic groups, aromatic groups.

5. (Original) A radiation-curable adhesive composition according to claim 4 wherein said aliphatic group has 1 to about 20 carbon atoms.

6. (Original) A radiation-curable adhesive composition according to claim 5 wherein said aliphatic group has 1 to 12 carbon atoms.

7. (Original) A radiation-curable adhesive composition according to claim 5 wherein said aromatic group has about 6 to about 20 carbon atoms.

8. (Original) A radiation-curable adhesive composition according to claim 5 wherein both R₁ and R₂ of the acrylate monomer is hydrogen.

9. (Currently Amended) A radiation-curable adhesive composition according to claim 1 wherein said acrylate monomer is selected from the group consisting of methyl acrylate, acrylic acid, methacrylic acid, methyl methacrylate, ethyl acrylate, ethyl methacrylate, butyl acrylate, butyl methacrylate, isobutyl acrylate, isobutyl methacrylate, n-hexyl acrylate, n-hexyl methacrylate, ethylhexyl acrylate, ethylhexyl methacrylate, n-heptyl acrylate, n-heptyl methacrylate, 2-methylheptyl(meth)acrylate, octyl acrylate, octyl methacrylate, iso-octyl(meth)acrylate, n-nonyl(meth)acrylate, iso-nonyl(meth)acrylate, decyl(meth)acrylate, isodecyl acrylate, isodecyl methacrylate, dodecyl(meth)acrylate, isobornyl(meth)acrylate, lauryl methacrylate, lauryl acrylate, tridecyl acrylate, tridecyl methacrylate, stearyl acrylate, stearyl methacrylate, glycidyl methacrylate, ~~alkyl crotonates, vinyl acetate, di-n-butyl maleate, di-octylmaleate,~~ acetoacetoxymethyl methacrylate, acetoacetoxymethyl acrylate, acetoacetoxymethyl methacrylate, acetoacetoxymethyl acrylate, diacetone acrylamide, acrylamide, methacrylamide, hydroxyethyl methacrylate, hydroxyethyl acrylate, allyl methacrylate, tetrahydrofurfuryl methacrylate, tetrahydrofurfuryl acrylate, cyclohexyl methacrylate,

cyclohexyl acrylate, n-hexyl acrylate, n-hexyl methacrylate, 2-ethoxyethyl acrylate, 2-ethoxyethyl methacrylate, isodecyl methacrylate, isodecyl acrylate, 2-methoxy acrylate, 2-methoxy methacrylate, 2-(2-ethoxyethoxy)ethylacrylate, 2-phenoxyethyl acrylate, 2-phenoxyethyl methacrylate, isobornyl acrylate, isobornyl methacrylate, caprolactone acrylate, caprolactone methacrylate, polypropyleneglycol monoacrylate, polypropyleneglycol monomethacrylate, polyethyleneglycol(400)acrylate, polypropyleneglycol(400)methacrylate, benzyl acrylate, benzyl methacrylate, ~~sodium 1-allyloxy-2-hydroxylpropyl sulfonate~~, acrylonitrile, and mixtures thereof.

10. (Original) A radiation-curable adhesive composition according to claim 1 wherein said acrylate monomer has up to about 20 carbon atoms.

11. (Original) A radiation-curable adhesive composition according to claim 10 wherein said acrylate monomer is selected from the group consisting of acrylic acid, 2-ethylhexyl acrylate, methyl methacrylate, methyl acrylate, acrylic acid, methacrylic acid, methyl methacrylate, ethyl acrylate, ethyl methacrylate, butyl acrylate, butyl methacrylate, isobutyl acrylate, isobutyl methacrylate, n-hexyl acrylate, n-hexyl methacrylate, ethylhexyl acrylate, ethylhexyl methacrylate, n-heptyl acrylate, n-heptyl methacrylate, 2-methylheptyl(meth)acrylate, octyl acrylate, octyl methacrylate, isoctyl (meth)acrylate, n-nonyl(meth)acrylate, iso-nonyl(meth)acrylate, decyl(meth)acrylate, isodecyl acrylate, isodecyl methacrylate, dodecyl(meth)acrylate, isobornyl(meth)acrylate, hydroxyethyl methacrylate, hydroxyethyl acrylate, allyl methacrylate, cyclohexyl methacrylate, cyclohexyl acrylate, n-hexyl acrylate, n-hexyl methacrylate, isobornyl acrylate, isobornyl methacrylate, and mixtures thereof.

12. (Original) A radiation-curable adhesive composition according to claim 11 wherein said acrylate monomer is acrylic acid and 2-ethylhexyl acrylate.

13. (Original) A radiation-curable adhesive composition according to claim 1 wherein said acrylate monomer contains at least one functional group selected from the group

consisting of hydroxy, cycloaliphatic, acid, epoxide, amide, acrylonitril and acrylate groups.

14. (Original) A radiation-curable adhesive composition according to claim 1 wherein said tackifier resin is produced by a radical catalyzed polymerization process utilizing at least one initiator.

15. (Original) A radiation-curable adhesive composition according to claim 14 wherein said initiator is selected from the group consisting of diacyl peroxides, dialkyl peroxidicarbonates, tert-alkyl peroxyesters, di-tert-alkyl peroxides, tert-alkyl hydroperoxides, ketone peroxides, and mixtures thereof.

16. (Canceled)

17. (Currently Amended) A radiation-curable adhesive composition according to Claim 1[[6]] wherein said tackifier resin is produced by a process comprising contacting a tackifier resin product stream with at least one carrier at a temperature sufficient to remove a portion of the residual monomers ~~to produce the tackifier resin having a low residual monomer concentration~~.

18. (Currently Amended) A radiation-curable adhesive composition according to claim 1[[6]] wherein said tackifier resin ~~having a low residual monomer concentration~~ does not significantly decrease the moisture vapor transport rate of said radiation-curable adhesive composition.

19. (Original) A radiation-curable adhesive composition according to claim 18 wherein said tackifier resin does not decrease the moisture vapor transport rate of said radiation-curable adhesive composition by more than 25%.

20. (Currently Amended) A radiation-curable adhesive composition according to claim 1[[6]] wherein the moisture vapor transport rate of said radiation-curable adhesive composition is the same or increased over said radiation-curable composition alone.

21. (Currently Amended) A radiation-curable adhesive composition according to claim 1[[6]] wherein the moisture vapor transport rate of said radiation-curable adhesive composition ranges from about 200 to about 3000.

22. (Original) A radiation-curable adhesive composition according to claim 21 wherein the moisture vapor transport rate of said radiation-curable adhesive composition ranges from about 500 to 1500.

23. (Canceled)

24. (Currently Amended) A radiation-curable adhesive composition according to claim 1[[23]] wherein said residual monomer concentration of said tackifier resin is less than about 300 ppm by weight based on the weight of said tackifier resin.

25. (Currently Amended) A radiation-curable adhesive composition according to claim 1[[6]] wherein said residual monomer concentration of said tackifier resin is less than about 200 ppm aromatic monomer based on the weight of said tackifier resin and less than about 400 ppm acrylic monomer.

26. (Original) A radiation-curable adhesive composition according to claim 25 wherein said residual monomer concentration of said tackifier resin is less than about 100 ppm by weight aromatic monomer and less than about 150 ppm by weight acrylic monomer.

27. (Currently Amended) A radiation-curable adhesive composition according to claim 1[[6]] wherein said tackifier resin having a low residual monomer concentration

has a residual solvent level less than about 500 ppm by weight based on the weight of said tackifier resin.

28. (Original) A radiation-curable adhesive composition according to claim 1 wherein the amount of aromatic monomer repeating units in the tackifier resin ranges from about 20% to about 70% based on the total amount of monomer repeating units in the tackifier resin.

29. (Original) A radiation-curable adhesive composition according to claim 1 wherein the amount of acrylate monomer repeating units in said tackifier resin ranges from about 30% to about 80% based on the total amount of monomer repeating units in the tackifier resin.

30. (Original) A radiation-curable adhesive composition according to claim 1 wherein said tackifier resin has a R&B softening point ranging from being a liquid at room temperature to about 180°C.

31. (Original) A radiation-curable adhesive composition according to claim 1 wherein said acid number of said tackifier resin ranges from about 0 to about 300 mg KOH/g resin.

32. (Original) A radiation-curable adhesive composition according to claim 1 wherein said hydroxyl number of said tackifier resin ranges from about 0 to about 300.

33. (Original) A radiation-curable adhesive composition according to claim 1 wherein the MMAP cloud point of said tackifier resin is less than 50°C.

34. (Original) A radiation-curable adhesive composition according to claim 1 wherein the number average molecular weight (M_n) of said tackifier resin ranges from about 1,500 to about 7,000 daltons.

35. (Original) A radiation-curable adhesive composition according to claim 1 wherein the number average molecular weight (M_n) of said tackifier resin ranges from 2,000 to 4,000 daltons.

36. (Original) A radiation-curable adhesive composition according to claim 1 wherein the weight average molecular weight (M_w) of the tackifier resin ranges from about 2,000 to about 25,000 daltons.

37. (Original) A radiation-curable adhesive composition according to claim 1 wherein the weight average molecular weight (M_w) of the tackifier resin ranges from 3,000 to 10,000.

38. (Original) A radiation-curable adhesive composition according to claim 1 wherein the z-average molecular weight (M_z) of said tackifier resin ranges from about 3,000 to about 75,000 daltons.

39. (Original) A radiation-curable adhesive composition according to claim 1 wherein the z-average molecular weight (M_z) of said tackifier resin ranges from 5000 to 20000.

40. (Original) A radiation-curable adhesive composition according to claim 1 wherein the Gardner color of said tackifier resin is less than 5.

41. (Original) A radiation-curable adhesive composition according to claim 1 wherein said tackifier resin has an aromaticity of 45% or higher and an acid number of 100 mg KOH/g resin or lower.

42. (Original) A radiation-curable adhesive composition according to claim 1 wherein said tackifier resin has a softening point of 80°C or higher.

43. (Currently Amended) A radiation-curable adhesive composition according to claim 1 wherein said tackifier resin comprises repeating units from at least one monomer selected from the group consisting of styrene, acrylic acid, and 2-ethylhexyl acrylate.

44. (Original) A radiation-curable adhesive composition according to claim 43 wherein the amount of styrene repeating units ranges from 0 to 100% based on the total amount of monomer repeating units in the tackifier resin.

45. (Original) A radiation-curable adhesive composition according to claim 44 wherein the amount of acrylic acid and 2-ethylhexyl acrylate ranges from 0-100% based on the total amount of monomer repeating units in the tackifier resin.

46. (Currently Amended) A radiation-curable adhesive composition according to claim 43 wherein said tackifier resin comprises repeating units of styrene and repeating units of acrylic acid and/or 2-ethylhexyl acrylate, and wherein the amount of styrene repeating units ranges from about 20% to about 70% based on the total amount of monomer repeating units in said tackifier resin, and the combined amount of acrylic acid repeating units, if present, and 2-ethylhexyl acrylate repeating units, if present, ranges from about 30% to about 80%.

47. (Original) A radiation-curable adhesive composition according to claim 1 wherein said radiation-curable composition is at least one selected from the group consisting of acrylic compositions, epoxides, urethanes, hybrid compositions, isoprene compositions, and styrene block copolymers.

48. (Original) A radiation-curable adhesive composition according to claim 47 wherein said acrylic compositions are selected from acrylic monomers, acrylic oligomers, and acrylic polymers.

49. (Original) A radiation-curable adhesive composition according to claim 48 wherein said acrylic monomer is at least one selected from the group consisting of acrylic acid, 2-ethylhexyl acrylate, methyl methacrylate, methyl acrylate, acrylic acid, methacrylic acid, methyl methacrylate, ethyl acrylate, ethyl methacrylate, butyl acrylate, butyl methacrylate, isobutyl acrylate, isobutyl methacrylate, n-hexyl acrylate, n-hexyl methacrylate, ethylhexyl acrylate, ethylhexyl methacrylate, n-heptyl acrylate, n-heptyl methacrylate, 2-methylheptyl(meth)acrylate, octyl acrylate, octyl methacrylate, isoctyl(meth)acrylate, n-nonyl(meth)acrylate, iso-nonyl(meth)acrylate, decyl(meth)acrylate, isodecyl acrylate, isodecyl methacrylate, dodecyl(meth)acrylate, isobornyl(meth)acrylate, hydroxyethyl methacrylate, hydroxyethyl acrylate, allyl methacrylate, cyclohexyl methacrylate, cyclohexyl acrylate, n-hexyl acrylate, n-hexyl methacrylate, isobornyl acrylate, isobornyl methacrylate, and mixtures thereof.

50. (Original) A radiation-curable adhesive composition according to claim 48 wherein said acrylic oligomers comprise at least one repeating unit selected from the group consisting of acrylic acid, 2-ethylhexyl acrylate, methyl methacrylate, methyl acrylate, acrylic acid, methacrylic acid, methyl methacrylate, ethyl acrylate, ethyl methacrylate, butyl acrylate, butyl methacrylate, isobutyl acrylate, isobutyl methacrylate, n-hexyl acrylate, n-hexyl methacrylate, ethylhexyl acrylate, ethylhexyl methacrylate, n-heptyl acrylate, n-heptyl methacrylate, 2-methylheptyl(meth)acrylate, octyl acrylate, octyl methacrylate, isoctyl(meth)acrylate, n-nonyl(meth)acrylate, iso-nonyl(meth)acrylate, decyl(meth)acrylate, isodecyl acrylate, isodecyl methacrylate, dodecyl(meth)acrylate, isobornyl(meth)acrylate, hydroxyethyl methacrylate, hydroxyethyl acrylate, allyl methacrylate, cyclohexyl methacrylate, cyclohexyl acrylate, n-hexyl acrylate, n-hexyl methacrylate, isobornyl acrylate, isobornyl methacrylate, and mixtures thereof.

51. (Original) A radiation-curable adhesive composition according to claim 48 wherein said acrylic polymers include both homopolymers, copolymers, and terpolymers produced from at least one monomer selected from the group consisting of methyl

acrylate, acrylic acid, methacrylic acid, methyl methacrylate, ethyl acrylate, ethyl methacrylate, butyl acrylate, butyl methacrylate, isobutyl acrylate, isobutyl methacrylate, n-hexyl acrylate, n-hexyl methacrylate, ethylhexyl acrylate, ethylhexyl methacrylate, n-heptyl acrylate, n-heptyl methacrylate, 2-methylheptyl(meth)acrylate, octyl acrylate, octyl methacrylate, iso-octyl(meth)acrylate, n-nonyl(meth)acrylate, iso-nonyl(meth)acrylate, decyl(meth)acrylate, isodecyl acrylate, isodecyl methacrylate, dodecyl(meth)acrylate, isobornyl(meth)acrylate, lauryl methacrylate, lauryl acrylate, tridecyl acrylate, tridecyl methacrylate, stearyl acrylate, stearyl methacrylate, glycidyl methacrylate, alkyl crotonates, vinyl acetate, di-n-butyl maleate, di-octylmaleate, acetoacetoxymethyl methacrylate, acetoacetoxymethyl acrylate, acetoacetoxymethyl methacrylate, acetoacetoxymethyl acrylate, diacetone acrylamide, acrylamide, methacrylamide, hydroxyethyl methacrylate, hydroxyethyl acrylate, allyl methacrylate, tetrahydrofurfuryl methacrylate, tetrahydrofurfuryl acrylate, cyclohexyl methacrylate, cyclohexyl acrylate, n-hexyl acrylate, n-hexyl methacrylate, 2-ethoxyethyl acrylate, 2-ethoxyethyl methacrylate, isodecyl methacrylate, isodecyl acrylate, 2-methoxy acrylate, 2-methoxy methacrylate, 2-(2-ethoxyethoxy)ethylacrylate, 2-phenoxyethyl acrylate, 2-phenoxyethyl methacrylate, isobornyl acrylate, isobornyl methacrylate, caprolactone acrylate, caprolactone methacrylate, polypropyleneglycol monoacrylate, polypropyleneglycol monomethacrylate, polyethyleneglycol(400)acrylate, polypropyleneglycol(400)methacrylate, benzyl acrylate, benzyl methacrylate, sodium 1-allyloxy-2-hydroxylpropyl sulfonate, acrylonitrile, and mixtures thereof.

52. (Original) A radiation-curable adhesive composition according to claim 48 wherein said acrylic polymers comprise repeating units from acrylic monomers and at least one polar copolymerizable monomers.

53. (Original) A radiation-curable adhesive composition according to claim 52 wherein said polar copolymerizable monomer is at least one selected from the group consisting of cyanoalkyl acrylates, acrylamides, substituted acrylamides, N-vinyl

pyrrolidone, N-vinyl caprolactam, acrylonitrile, vinyl chloride, vinylidene chloride, diallyl phthalate, and mixtures thereof.

54. (Currently Amended) A radiation-curable adhesive composition according to claim 48[[1]] wherein said radiation-curable acrylic polymers are selected from the group consisting of acrylic copolymers, acrylated polyethers, acrylated polyester-based polyurethanes, methacrylated polyesters, and acrylated epoxies.

55. (Original) A radiation-curable adhesive composition according to claim 54 wherein said radiation-curable acrylic polymer is a ultraviolet light reactive, solvent free acrylic copolymer with a Tg of less than or equal to about -32°C or lower and a viscosity of less than or equal to about 24000 mPa.s at 120°C.

56. (Original) A radiation-curable adhesive composition according to claim 1 wherein the amounts of said tackifier resin ranges from about 0.1% to about 50% based on the weight of the radiation-curable adhesive composition.

57. (Original) A radiation-curable adhesive composition according to claim 56 wherein the amounts of tackifier resin ranges from 0.1% to 25% based on the weight of the radiation-curable adhesive composition.

58. (Original) A radiation-curable adhesive composition according to claim 1 further comprising at least one photo-initiator.

59. (Original) A radiation-curable adhesive composition according to claim 1 further comprising at least one crosslinking agent.

60. (Original) A radiation-curable adhesive composition according to claim 1 further comprising at least one additive selected the group consisting of reinforcing agents, fire retardants, foaming agents, conventional tackifiers, plasticizers, oils,

antioxidants, polymers, curable/reactive monomers, crosslinking agents, fillers, and pigments.

61. (Withdrawn) A radiation-cured adhesive composition comprising at least one tackifier resin, at least one radiation-curable composition, and at least one substrate; wherein said tackifier resin comprises monomer repeating units from at least one aromatic monomer and at least one acrylate monomer; wherein said radiation-curable composition is exposed to radiation.

62. (Withdrawn) A radiation-cured adhesive composition according to claim 61 wherein said radiation is selected from ultraviolet light, electron beam, gamma ray, and X-ray.

63. (Currently Amended) A process of making a radiation-curable adhesive composition, said process comprising providing at least one tackifier resin and at least one radiation-curable composition wherein said tackifier resin comprises monomer repeating units from at least one aromatic monomer and at least one acrylate monomer, wherein said tackifier resin has a residual monomer concentration of less than about 600 ppm by weight based on the weight of said tackifier resin.

64. (Withdrawn) A process of making a radiation-cured adhesive composition said process comprises: 1) providing at least one tackifier resin and at least one radiation-curable composition to produce a radiation-curable adhesive composition, 2) contacting said radiation-curable adhesive composition with at least one substrate, and 3) exposing said radiation-curable adhesive composition to radiation in an amount sufficient to produce said radiation-cured adhesion composition; wherein said tackifier resin comprises monomer repeating units from at least one aromatic monomer and at least one acrylate monomer.

65. (Withdrawn) A process according to claim 64 wherein said radiation is selected from ultraviolet light, electron beam, gamma ray, and X-ray radiation.

66. (Withdrawn) A process according to claim 65 wherein said radiation is ultraviolet light having an effective ultraviolet wavelength ranging from about 100 nm to about 400 nm.

67. (Withdrawn) A process according to claim 65 wherein said radiation is electron beam radiation in an amount ranging from about 1 megarads (Mrads) to about 30 Mrads.

68. (Withdrawn) A process according to claim 64 wherein said substrate is selected from the group consisting of polyethylene terephthalate, biaxially oriented polypropylene, woven fabrics, non-woven fabrics, metals, metal foils, paper, glass, ceramics, and composite materials comprising laminates of one or more of these materials.

69. (Withdrawn) A process to produce a UV-cured adhesive composition, said process comprising: 1) contacting a styrene-acrylate tackifier resin and an acrylic copolymer to produce a UV-curable adhesive composition; wherein said styrene-acrylate tackifier comprises repeating units from styrene, acrylic acid and 2-ethylhexyl acrylate, 2) contacting the UV-curable adhesive composition with at least one substrate, and 3) exposing the UV-curable adhesive composition to UV light having a wavelength in a range of 220 nm to about 280 nm to produce and UV-cured adhesive composition.

70. (Withdrawn) A process to produce a radiation-cured adhesive composition, said process comprising: 1) contacting at least one radiation-curable acrylic monomer or oligomer, at least one photo-initiator, and optionally a thixotropic agent to produce a mixture, 2) polymerizing said mixture to a viscosity sufficient to produce a coatable syrup, 3) mixing at least one tackifier resin with said coatable syrup to produce said

radiation-curable adhesive composition, and 4) optionally, adding additional photo-initiator to said radiation-curable adhesive composition, 5) coating said radiation-curable onto at least one substrate to produce a coated substrate; and 6) exposing said coated substrate to radiation in an inert atmosphere.

71. (Original) An article comprising said radiation-curable adhesive composition of claim 1.

72. (Withdrawn) An article comprising said radiation-cured adhesive composition of claim 61.

73. (New) A radiation-curable adhesive composition comprising at least one tackifier resin and at least one radiation-curable composition, wherein said tackifier resin comprises monomer repeating units from at least one aromatic monomer and at least one acrylate monomer, and wherein said tackifier resin is produced by a process comprising contacting a tackifier resin product stream with a carrier to remove a portion of at least one residual monomer from said tackifier resin product stream.

74. (New) A radiation-curable adhesive composition according to claim 73 wherein said carrier is selected from the group consisting of steam, nitrogen, ethane, and combinations thereof.

75. (New) A radiation-curable adhesive composition according to claim 73 wherein said carrier comprises steam.

76. (New) A radiation-curable adhesive composition according to claim 73 wherein said process further comprises heating said tackifier resin product stream prior to and/or during said contacting with said carrier.

77. (New) A radiation-curable adhesive composition according to claim 73 wherein said contacting of said tackifier resin product stream with said carrier is carried out at a temperature in the range of from about 150°C to about 250°C.

78. (New) A radiation-curable adhesive composition according to claim 73 wherein said tackifier resin has a residual monomer concentration of less than about 600 ppm by weight of said tackifier resin.

79. (New) A radiation-curable adhesive composition according to claim 73 wherein said aromatic monomer is selected from the group consisting of styrene, alpha-methyl styrene, vinyl toluene, indene, methylindenes, divinylbenzene, dicyclopentadiene, and methyl-dicyclopentadiene.

80. (New) A radiation-curable adhesive composition according to claim 73 wherein said acrylate monomer is acrylic acid and 2-ethylhexyl acrylate.

81. (New) A radiation-curable adhesive composition according to claim 73 wherein said tackifier resin comprises repeating units of styrene and repeating units of acrylic acid and/or 2-ethylhexyl acrylate, and wherein the amount of styrene repeating units ranges from about 20% to about 70% based on the total amount of monomer repeating units in said tackifier resin, and the combined amount of acrylic acid repeating units, if present, and 2-ethylhexyl acrylate repeating units, if present, ranges from about 30% to about 80%.